Section 4

Plant Responses and Growth

Objectives

After this lesson, students will be able to

A.5.4.1 Identify three stimuli that produce plant responses.

A.5.4.2 Describe how plants respond to seasonal changes.

A.5.4.3 State how long different angiosperms live.

Target Reading Skill

Relating Cause and Effect Explain that cause is the reason for what happens. The effect is what happens because of the cause. Relating cause and effect helps students relate the reason for what happens to what happens as a result.

Answers

Effects: Tropisms; Germination; Forming flowers, stems, leaves; Shedding leaves; Development and ripening of fruit

All in One Teaching Resources

- Transparency A48

Preteach

Build Background Knowledge

L2

Descriptions of Plant Growth

Ask students to describe the usual direction of root and stem growth for plants on Earth. *(Roots grow downward; stems grow upward.)* Tell students that researchers are studying how plants grow in low gravity conditions. This knowledge could help them develop food crops for future space expeditions. Challenge students to speculate how low gravity conditions might affect plant growth. *(Possible answer: Plants might not grow in the same orientation as they do on Earth.)*

Section 4

Plant Responses and Growth

Reading Preview

Key Concepts

- What are three stimuli that produce plant responses?
- How do plants respond to seasonal changes?
- How long do different angiosperms live?

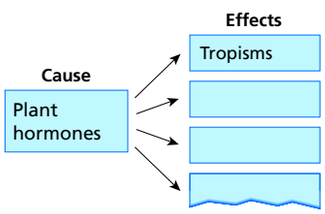
Key Terms

- tropism
- hormone
- auxin
- photoperiodism
- short-day plant
- long-day plant
- critical night length
- day-neutral plant
- dormancy
- annual
- biennial
- perennial

Target Reading Skill

Relating Cause and Effect

A cause makes something happen. An effect is what happens. As you read through the paragraphs under the heading Hormones and Tropisms, identify four effects of plant hormones. Write the information in a graphic organizer like the one below.



Lab zone Discover Activity

Can a Plant Respond to Touch?

1. Your teacher will give you two plants. Observe the first plant. Gently touch a leaf with the tip of a pencil. Observe what happens over the next three minutes. Record your observations.
2. Repeat Step 1 with the second plant. Record your observations.
3. Wash your hands with soap and water.

Think It Over

Inferring What advantage might a plant have if its leaves responded to touch?

The bladderwort is a freshwater plant with small yellow flowers. Attached to its floating stems are open structures called bladders. When a water flea touches a sensitive hair on a bladder, the bladder flicks open. Faster than you can blink, the water flea is sucked inside, and the bladder snaps shut. The plant then digests the trapped flea.

A bladderwort responds quickly—faster than many animals respond to a similar stimulus. You may be surprised to learn that some plants have lightning-quick responses. In fact, you might have thought that plants do not respond to stimuli at all. But plants do respond to some stimuli, although they usually do so more slowly than the bladderwort.

Tropisms

Animals usually respond to stimuli by moving. Unlike animals, plants commonly respond by growing either toward or away from a stimulus. A plant's growth response toward or away from a stimulus is called a **tropism** (TROH piz um). If a plant grows toward the stimulus, it is said to show a positive tropism. If a plant grows away from a stimulus, it shows a negative tropism. **Touch, light, and gravity are three important stimuli to which plants show growth responses, or tropisms.**

Lab zone Discover Activity

Skills Focus Inferring L1

Materials touch-sensitive plant such as a Venus' flytrap or mimosa; common houseplant such as a geranium or impatiens

Time 10 minutes

Tips If you have difficulty obtaining sensitive plants, contact a biological supply house or specialty gardening shop. Remind students to wash their hands after touching the plants.

Expected Outcome The leaf of the sensitive plant closes when it is touched. The leaf of the houseplant does not respond.

Think It Over Students might infer that having sensitive leaves helps protect a plant from predators and environmental conditions.

Touch Some plants, such as bladderworts, show a response to touch called thigmotropism. The prefix *thigmo-* comes from a Greek word that means "touch." The stems of many vines, such as grapes and morning glories, show a positive thigmotropism. As the vines grow, they coil around any object that they touch.

Light Have you ever noticed plants on a windowsill with their leaves and stems facing the sun? All plants exhibit a response to light called phototropism. The leaves, stems, and flowers of plants grow toward light, showing a positive phototropism. By growing towards the light, a plant receives more energy for photosynthesis.

Gravity Plants also respond to gravity. This response is called gravitropism. Roots show positive gravitropism—they grow downward. Stems, on the other hand, show negative gravitropism—they grow upward.

Hormones and Tropisms Plants are able to respond to touch, light, and gravity because they produce hormones. A **hormone** produced by a plant is a chemical that affects how the plant grows and develops.

One important plant hormone is named **auxin** (AWK sin). Auxin speeds up the rate at which a plant's cells grow. Auxin controls a plant's response to light. When light shines on one side of a plant's stem, auxin builds up in the shaded side of the stem. The cells on the shaded side begin to grow faster. Eventually, the cells on the stem's shaded side are longer than those on its sunny side. So the stem bends toward the light.

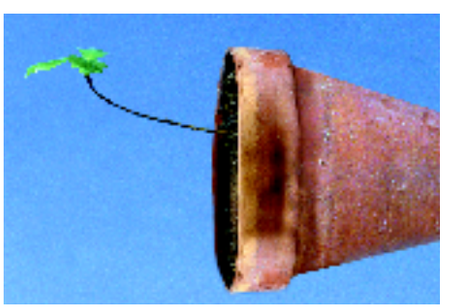
In addition to tropisms, plant hormones also control many other plant activities. Some of these activities are germination, the formation of flowers, stems, and leaves, the shedding of leaves, and the development and ripening of fruit.

Reading Checkpoint **What is one role that the plant hormone auxin plays?**

FIGURE 19
Tropisms
Touch, light, and gravity are three stimuli to which plants show growth responses, or tropisms.

▲ **Touch** A vine coiling around a wire shows positive thigmotropism.

▲ **Light** A plant's stems and flowers growing toward light show positive phototropism.



▲ **Gravity** A plant's stem growing upward, against the pull of gravity, shows negative gravitropism.

Differentiated Instruction

Special Needs L1

Modeling Plant Response Some students may have difficulty understanding that auxin makes some plant cells grow longer and the auxin elongated cells are on the shaded side of the plant. Decide which side of a coiled spring toy will represent the shaded side of a plant. Have students hold the toy and cause one side to elongate, or "grow." The spring toy will bend away from the elongated side. Ask: **Which way does the toy bend?** *(It bends away from the lengthened coils.)* **How does this model a plant's response?** *(A plant bends toward the light, or away from the shaded side.)* **learning modality: kinesthetic**

Instruct

Tropisms

Teach Key Concepts L2

Stimulus Responses

Focus Prompt students to think about the response of the sensitive plant to touch in the Discover Activity.

Teach Ask: **How did the sensitive plant respond to touch?** *(It closed.)* **What is a response to touch called?** *(Thigmotropism)* **Was the response positive or negative? Explain.** *(The response was negative, the plant pulled away from the stimulus.)* Ask students to read the captions in Figure 19 and describe two other stimuli to which plants show tropism. Then ask: **What kind of gravitropism do a plant's roots show if they grow downward? Explain.** *(Positive gravitropism; they grow toward the pull of gravity.)*

Apply Explain that not all touch responses are controlled by hormones. The mimosa plant in the Discover Activity, for example, closed because water was quickly pumped out, causing the leaves to fold. **learning modality: verbal**

Independent Practice L2

All in One Teaching Resources

- Guided Reading and Study Worksheet: *Plant Responses and Growth*

Student Edition on Audio CD

Monitor Progress L2

Writing Have students explain how plants exhibit positive phototropism and positive and negative gravitropism.

Answers

Reading Checkpoint It speeds up the rate at which plant cells grow.

Go Online SCILINKS NSTA

For: Links on plant responses
Visit: www.SciLinks.org
Web Code: scn-0154

Download a worksheet to guide students' review of plant responses.

Seasonal Changes

Teach Key Concepts L2

The Factor of Darkness in Blooming

Focus Ask: **Why don't some plants bloom in winter in locations that have seasonal changes?** *(Temperatures are too low and days are too short.)*

Teach Ask: **What environmental factor triggers plants to flower?** *(The amount of darkness a plant receives)* **What is photoperiodism?** *(A plant's response to hours of light and darkness)* **When does a short-day plant flower?** *(When nights are longer than its critical night length)* **A long-day plant?** *(When nights are shorter than its critical night length)* **If a long-day plant has a critical night length of 10 hours, when will it flower?** *(When nights are shorter than 10 hours)* **What are plants that bloom no matter what the periods of darkness called?** *(Day-neutral plants)*

Apply Ask students to infer the advantage of different plants flowering at different times of the year. *(Possible answers: The plant's pollinators may pollinate only during certain times of the year. Plants have adapted to the climate—for example, a particular plant may not be able to flower during the summer.)* **learning modality: logical/mathematical**

All in One Teaching Resources

- Transparency A49

Help Students Read

Sequencing Refer to the Content Refresher for guidelines on sequencing. After students have read the passage *Winter Dormancy,* have them sketch the steps showing the changes a tree undergoes when winter approaches. Have them label each step and write in their own words what happens.

FIGURE 20
Short-day and Long-day Plants
A short-day plant flowers when nights are longer than the critical night length. A long-day plant flowers when nights are shorter than the critical night length. **Applying Concepts** *Which plant—chrysanthemum or iris—would most likely flower in the early summer?*

Short-Day Plant		Long-Day Plant	
Longer than critical night length	Shorter than critical night length	Longer than critical night length	Shorter than critical night length
			
Chrysanthemum	Chrysanthemum	Iris	Iris

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Seasonal Changes

You may have heard the saying "April showers bring May flowers," but have you ever wondered whether it's true? Do all flowers bloom in May? Is it really rain that makes flowers bloom?

People have long observed that plants respond to the changing seasons. Some plants bloom in early spring, while others don't bloom until summer. The leaves on some trees change color in autumn and then fall off by winter.

Photoperiodism What environmental factor triggers a plant to flower? **The amount of darkness a plant receives determines the time of flowering in many plants.** A plant's response to seasonal changes in length of night and day is called **photoperiodism.**

Plants differ in how they respond to the length of nights. **Short-day plants** flower when nights are *longer* than a critical length. **Long-day plants** flower when nights are *shorter* than a critical length. This critical length, called the **critical night length,** is the number of hours of darkness that determines whether or not a plant will flower. For example, if a short-day plant has a critical night length of 11 hours, it will flower only when nights are longer than 11 hours.

Short-day plants bloom in the fall or winter, when nights are growing longer. Chrysanthemums and poinsettias are short-day plants. In contrast, long-day plants flower in the spring or summer, when nights are getting shorter. Long-day plants include irises and lettuce.

Other plants, such as dandelions, rice, and tomatoes, are **day-neutral plants.** Their flowering cycle is not sensitive to periods of light and dark.

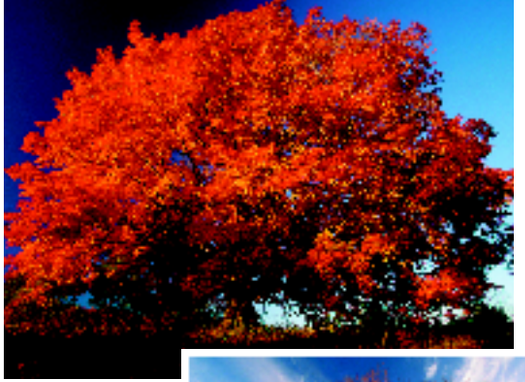


FIGURE 21
Winter Dormancy
As winter approaches, the leaves on this sugar maple turn color and then fall to the ground.

Winter Dormancy As winter draws near, many plants prepare to go into a state of dormancy. **Dormancy** is a period when an organism's growth or activity stops. **Dormancy helps plants survive freezing temperatures and the lack of liquid water.**

With many trees, the first change is that the leaves begin to turn color. Cooler weather and shorter days cause the leaves to stop making chlorophyll. As chlorophyll breaks down, yellow and orange pigments become visible. In addition, the plant begins to produce new red pigments. The brilliant colors of autumn leaves result.

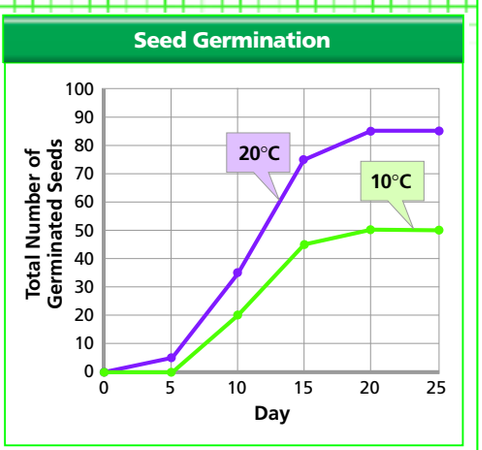
Over the next few weeks, all of the remaining sugar and water are transported out of the tree's leaves. The leaves then fall to the ground, and the tree is ready for winter.

Reading Checkpoint **What is dormancy?**

Math Analyzing Data

Germination and Temperature

One hundred radish seeds were planted in each of two identical trays of soil. One tray was kept at 10°C, and one tray was kept at 20°C. The trays received equal amounts of water and sunlight. The graph shows how many seeds germinated over time at each temperature.



1. **Reading Graphs** What variable is plotted on the horizontal axis? What variable is plotted on the vertical axis?
2. **Interpreting Data** How did the number of seeds that germinated change between day 20 and day 25 at 10°C? At 20°C?
3. **Drawing Conclusions** According to the graph, at which temperature did more seeds eventually germinate? What can you conclude about the relationship between temperature and germination?
4. **Predicting** Predict what the graph would look like for a tray of 100 radish seeds kept at 5°C. Give a reason for your prediction.

Math Analyzing Data

Math Skill Interpreting graphs

Focus Explain that line graphs compare variables over time.

Teach Tell students to find "20 days" on the horizontal axis, then follow that line upward until it meets the line for "10°C." Read across to the vertical axis value—50 seeds.

Answers

1. Days; total number of germinated seeds
2. The numbers did not change.
3. 20°C; the number of germinating seeds increases as the temperature increases.
4. The slope would be less steep because fewer seeds would germinate.

Differentiated Instruction

Gifted and Talented L3
Investigating Flower Induction Invite students to research how greenhouse managers bring flowers to bloom for specific seasons, such as poinsettas, and how they induce seasonal plants, such as chrysanthemums, to bloom all year.
learning modality: verbal

Less Proficient Readers L1
Outlining Provide students with copies of an outline with the headings and subheadings of this section and blank lines under each heading. Have students fill in details under each heading as they read. Direct student pairs to generate questions from their outlines and quiz one another.
learning modality: verbal

Monitor Progress L2

Skills Check Have students make a compare/contrast table of the types of photoperiodism in plants. Students can place their tables in their portfolios.

Portfolio

Answers

Figure 20 Iris

Reading Checkpoint A period when an organism's growth or activity stops

Life Spans of Angiosperms

Teach Key Concepts L2

Annuals, Biennials, and Perennials

Focus Review the meanings of the terms *annual, biennial,* and *perennial.*

Teach Ask: **What are the life spans of angiosperms?** *(Annuals—one growing season, biennial—two years; perennials—many years)*

Apply Ask: **Why are trees sold as seedlings rather than seeds?** *(Trees are perennials and too slow-growing to start as seeds.)* **learning modality: verbal**

Monitor Progress L2

Answer

Reading Checkpoint Two years

Assess

Reviewing Key Concepts

1. a. Thigmotropism—a plant's response to touch; phototropism—a plant's response to light; gravitropism—a plant's response to gravity **b.** It makes the cells on the shaded side grow longer than other cells. **c.** Possible answer: The plants display positive thigmotropism to cling to something for support.

2. a. A plant's response to seasonal changes in length of night and day; a period when an organism's growth or activity stops

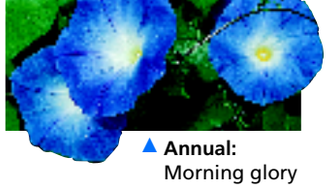
b. Short-day plants bloom when nights are longer than a critical length. Long-day plants bloom when nights are shorter than a critical length. **c.** Leaves stop making chlorophyll. Chlorophyll breaks down. Pigments masked by chlorophyll become visible. New red pigments are produced. Remaining sugar and water leave the leaves. Leaves fall to the ground.

3. a. Annuals complete a life cycle within one growing year, biennials within two years, and perennials more than two years.

b. Perennial; it lives for many years.

Reteach L1

Sketch examples of tropisms, photoperiodism, and dormancy, and have students describe them.



▲ **Annual:** Morning glory

Biennial: ▶ Foxglove

▲ **Perennial:** Peony

FIGURE 22 Life Spans of Angiosperms Annuals live for one year. Biennials live for two years, and perennials live for many years.

Life Spans of Angiosperms

Angiosperms are classified as annuals, biennials, or perennials based on the length of their life cycles. Flowering plants that complete a life cycle within one growing season are called **annuals.** Most annuals have herbaceous stems. Annuals include marigolds, petunias, wheat, and cucumbers.

Angiosperms that complete their life cycle in two years are called **biennials** (by EN ee ulz). In the first year, biennials germinate and grow roots, very short stems, and leaves. During their second year, biennials lengthen their stems, grow new leaves, and then produce flowers and seeds. Once the flowers produce seeds, the plant dies. Parsley, celery, and foxglove are biennials.

Flowering plants that live for more than two years are called **perennials.** Most perennials flower every year. Some perennials, such as peonies, have herbaceous stems. The leaves and stems of these plants die each winter, and new ones are produced each spring. Most perennials, however, have woody stems that live through the winter. Maple trees are examples of woody perennials.

Reading Checkpoint **How long does a biennial live?**

Section 4 Assessment

Target Reading Skill **Relating Cause and Effect** Refer to your graphic organizer about plant hormones to help you answer Question 1 below.

Reviewing Key Concepts

1. **a.** **Describing** Describe three tropisms that take place in plants.
   b. **Explaining** How does auxin control a plant's response to light?
   c. **Developing Hypotheses** The stems of your morning glory plants have wrapped around your garden fence. Explain why this has occurred.
2. **a.** **Defining** What is photoperiodism? What is winter dormancy?
   b. **Comparing and Contrasting** How do short-day plants and long-day plants differ?
   c. **Sequencing** List in order the changes that a tree undergoes as winter approaches.
3. **a.** **Defining** How do annuals, biennials, and perennials differ?
   b. **Applying Concepts** Is the grass that grows on most lawns an annual, a biennial, or a perennial? Explain.

Lab zone At-Home Activity

Sun Seekers With a family member, soak some corn seeds or lima bean seeds in water overnight. Then push them gently into some soil in a paper cup until they are just covered. Keep the soil moist. When you see the stems break through the soil, place the cup in a sunny window. After a few days, explain to your family member why the plants grew in the direction they did.

All in One **Teaching Resources**

- Section Summary: *Plant Responses and Growth*
- Review and Reinforce: *Plant Responses and Growth*
- Enrich: *Plant Responses and Growth*

Lab zone At Home Activity

Sun Seekers L2 Review the explanation with students: the plants respond with positive phototropism because they grow toward light. Ask students to identify what part of the seedling demonstrated positive gravitropism. *(Roots)*